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Imaging Detection of Metallic Objects using a Giant Magnetoresistive Sensor Array

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False positive detections account for a great part of the expense associated with remediation of areas contaminated with unexploded ordnance (UXO) or mines. Presently fielded systems like pulsed electromagnetic induction systems and cesium-vapor magnetometers have difficulty distinguishing between threatening objects and other metallic ground clutter. An imaging array detector would allow its operator to more readily distinguish between mines/UXO and benign objects (like shrapnel or bullets) that litter military sites.

The discovery of giant magnetoresistance (GMR) has led to the development of a new generation of integrated-circuit magnetic sensors that are far more sensitive than previously available room-temperature-operation electronic devices. The small size of GMR sensors makes possible the construction of array detectors that can be used to image the magnetic flux emanating from currents driven in a metallic object. In order to demonstrate the potential of the GMR-based imaging technology, a crude magnetic imaging system has been constructed using commercially available GMR devices. This system has been used to image a number of ferrous objects in zero applied field, and in addition the effect of a small applied field has been investigated. While the demonstration system lacks many of the features that would be integral to an actual mine detector, it serves to illustrate the manner in which a magnetic imaging system works. In particular, the ability to roughly determine the outline and disposition of magnetic objects has been demonstrated. These objects may be imaged even in the presence of a uniform background magnetic field, indicating that the GMR imaging technology holds promise for sites with magnetic volcanic soils such as the Kahoolawe bombing range. Part of this work was performed under the auspices of the U.S. Department of Energy (DOE) by LLNL under contract number W-7405-ENG-48.